Red Tree Vole Conservation Plan for Lawson Creek, Shasta Costa Creek, and Stair Creek Fifth-field Watersheds

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I. Summary

The red tree vole (RTV) conservation plan described herein was developed consistent with the *High Priority Site Management Recommendations* to provide a reasonable assurance of RTV persistence within three fifth-field watersheds - Lawson, Shasta Costa, and Stair Creek - located within Curry County, Oregon. The goal of the plan is to identify National Forest System lands (USDA Forest Service) that would be managed to provide suitable habitat for a well distributed population of red tree voles and allow linkages to adjacent watersheds. The plan includes a total of 83,391 acres which represents 68% of the area of the three watersheds. An additional 568 acres were added to the RTV Plan from the adjacent Indigo Creek watershed to enhance connectivity, resulting in a total of 83,959 acres to be managed consistent with red tree vole conservation. This document describes how the plan meets the rule set of the *High Priority Site Management Recommendations* and ultimately provides a science-based conservation strategy for RTV persistence. The plan was updated by the author to address the 2018 Klondike fire, and to revise the designation of a relatively small area to the original intent as a non-high priority site.

Upon plan approval through the final Record of Decision for the Shasta Agness Landscape Restoration Project, all National Forest System lands within the RTV Plan area would be designated in one of three categories as follows:

1) **LUA-RTV - Areas managed consistent with RTV conservation** within reserve land use allocations (LSR, wilderness, etc.). No activities would occur which trigger pre-disturbance surveys for RTV.

2) **Hybrid-HPS – Hybrid high-priority sites** designated for RTV conservation which are composed of both matrix and riparian reserve (hybrid) land-use allocations. No activities would occur which trigger pre-disturbance surveys for RTV. This category was added to enlarge selected riparian reserves to increase connectivity to adjacent watersheds from large LUA-RTVs. They provide conservation areas large enough to support multiple, interconnected populations in the southern portion of the RTV Plan area. Most (86%) of hybrid-HPSs are unsuitable RTV habitat as of 2017.

3) **Non-HPS - Non-high priority sites** are all remaining areas and would not be designated for RTV conservation. Pre-disturbance RTV surveys and/or site protection buffers would not be required in this designation.

II. Background

Purpose of Document in Relation to Policy

The conservation plan described within this document (hereafter "RTV Plan") provides a reasonable assurance of red tree vole persistence (*Arborimus longicaudus*) within three watersheds whose federal forests are managed by the Gold Beach Ranger District ("District"). This plan meets or exceeds the conservation provided by following the process as established in the red tree vole high priority site management recommendations (Huff 2016). The three fifth-field watersheds covered by this plan - Lawson Creek, Shasta Costa Creek, and Stair Creek - are almost entirely within Curry County, Oregon, southwest Oregon, and entirely within the southern portion of the red tree vole's range.

Red tree voles are considered a category C survey and manage species, thus requiring mitigation when habitat-disturbing activities occur within potentially suitable habitat (USDA Forest Service and USDI

Bureau of Land Management 2001, Huff 2016). Mitigation requires pre-disturbance surveys and a minimum of a10 acre habitat protection buffer surrounding one nest tree located during surveys with sites incrementally growing depending on the number of nests located (USDA Forest Service and USDI Bureau of Land Management 1994, 2001; Rosenberg et al. 2016). Alternatively, as a category C species, management recommendations could be developed that identify "high-priority sites" as well as sites and areas no longer requiring surveys or site management, in order to provide a reasonable assurance of species persistence. A *High-Priority Site Management Recommendation* (HPS MR) for red tree voles was recently developed (Huff 2016) and transmitted to field units. The HPS MR outlines a process to develop a conservation plan that is intended to provide a reasonable assurance of species persistence in one or more fifth-field watersheds (Huff 2016). The plan must follow the rule set described in the HPS MR. The plan must be included in project-level National Environmental Policy Act (NEPA) analyses conducted by the District. Upon plan approval, areas within the watersheds and under Forest Service management that are not designated as part of the conservation plan will no longer require surveys prior to habitat-disturbing activities nor site or habitat protection because they are considered non-high priority sites (Huff 2016; USDA Forest Service and USDI Bureau of Land Management 2001). This document describes and displays the conservation plan for the red tree vole in the Lawson Creek, Shasta Costa Creek, and Stair Creek fifth-field watersheds (hereafter "RTV Plan watersheds") and describes how the plan meets the rule set of the HPS MR and ultimately provides a science-based conservation strategy for red tree vole persistence.

Summary of Rule Set Used in Developing the RTV Plan

The rule set described by Huff (2016) is aimed at providing a well-distributed, interconnected population of red tree voles throughout federally managed lands in fifth-field watersheds. The key objective is to provide suitable habitat for species persistence within the watershed(s) and allow movement (hereafter "connectivity") of red tree voles within the watershed and into adjacent watersheds. The RTV Plan watersheds are primarily comprised of reserve land use allocations (Fig. 1, Table 1) intended for late-successional and old growth ecological values (USDA Forest Service and USDI Bureau of Land Management 1994). There is extensive red tree vole habitat within the reserve land-use allocations (Table 2) providing habitat for interconnected populations of red tree voles. The RTV Plan therefore includes primarily areas managed consistent with red tree vole conservation, namely reserve land-use allocations under the Rogue River-Siskiyou National Forest Land and Resource Management Plan (USDA Forest Service 1989) as amended by the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994). The rule set requires identification of the following elements, taken from Huff (2016:14):

1) Land-use allocations managed consistent with red tree vole conservation;
2) High-priority sites outside of those areas;
3) Connectivity areas linking sites and land-use allocations managed consistent with red tree vole conservation;
4) Non-high priority sites where pre-disturbance surveys and site management are no longer required;
5) Information gaps;
6) New information that would trigger revision of the RTV Plan.

The RTV Plan follows the rule set, as described in section "How this Plan Meets the High Priority Site Management Recommendations Rule Set"**.** Below, we outline the general rules described in the HPS MR that we used to guide the development of the RTV Plan.

1) Portions of land-use allocations managed for red tree vole conservation should not include areas whose management would require pre-disturbance activities;

2) The larger the area for red tree vole conservation, the greater flexibility allowed for the composition of the site regarding stand ages. Large is defined as >25 acres, and areas identified for red tree vole conservation should be >10 acres;
3) Young forests (forest stands < 80 years) may be included in some situations for red tree vole conservation areas;
4) Conservation areas should be well-distributed within the watershed, including the edge of the watershed;
5) Conservation areas should consider connectivity for vole populations and be comprised of suitable habitat;
6) Connectivity corridors should be ≥300 feet wide and long and ≥5 acres, and non-forest openings in areas for connectivity should be <100 feet;
7) Connectivity to adjacent watersheds must link to areas within the watersheds that provide for red tree vole persistence.

III. Data and Models Used in Designing Plan

Evaluation of Frequency of Occurrence

As a broad evaluation of the potential distribution of red tree voles in the RTV Plan watersheds, we used the 2001-2004 survey data collected from randomly selected 1 ha plots throughout the species range, stratified on stand age class regardless of whether in the reserve or matrix land-use allocations (Rittenhouse et al. 2002, Dunk and Hawley 2009, Rosenberg et al. 2016). These data provide the most rigorous data available to evaluate the relative frequency of occurrence throughout the species range (Rosenberg et al. 2016). We included three spatial scales for evaluating relative occurrence patterns within the RTV Plan watersheds: physiographic provinces using the subregions described by Forsman et al. (2016), delineations of the mesic, north mesic, and xeric zones (Huff et al. 2012), and density contours (Rosenberg et al. 2016). Density contours identified five areas throughout the species range where red tree voles were estimated to have low to high relative densities. Frequency of occurrence was estimated as the proportion of 1 ha plots with either active or inactive red tree vole nests detected (Rosenberg et al. 2016).

Evaluation of Habitat Suitability

The HPS MR allows for assessment of suitable habitat through modeling approaches (Huff 2016:14). Habitat models provide an appropriate approach for assessing large areas for conservation planning and provide a means for including areas where tree voles may be present but not detected or where they may be absent because suitable habitat may not be presently occupied (Rosenberg et al. 2016).

Three modeling approaches have been used to estimate and predict habitat suitability for red tree voles (Dunk and Hawley 2009, Forsman et al. 2016, Rosenberg et al. 2016). The three approaches were compared and evaluated by Rosenberg et al. (2016). There are strengths and weaknesses to each approach. However, predictions that were consistent across all three modeling approaches performed best, the so-called Ensemble model (Rosenberg et al. 2016). However, over the entire range of the red tree vole, only about 60% of the area had consistent estimates and this partial coverage was even more pronounced in the RTV Plan watersheds, where the ensemble model covered only 40% of the federal land. For this reason, we relied on the model BEST9 (Rosenberg et al. 2016) to guide selection of areas that would provide the building blocks of the conservation strategy and to estimate the acreage of suitable habitat within the RTV Plan. BEST9 covered almost the entire RTV Plan watershed under federal management and overall had the best performance of the three models (Rosenberg et al. 2016). Because the model was based on gradient nearest neighbor (GNN) vegetation database and models, we also used

aerial imagery from half-meter resolution color digital orthophoto quadrangles created in 2011 (http://imagery.oregonexplorer.info/arcgis/rest/services/NAIP_2011/NAIP_2011_WM/ImageServer; accessed 31 March 2017) to expand on the model-based predictions of suitable habitat. This approach gave finer resolution of habitat suitability than the models alone.

BEST9, the model we used to guide the RTV Plan, was evaluated in Rosenberg et al. (2016) using data from a broad array of red tree vole surveys. Because red tree vole surveys were primarily conducted in potentially suitable habitat, BEST9 was largely based on vegetation structure and geographic location rather than tree species. Therefore, areas in forests dominated by tree species where red tree voles do not exist, such as high elevation forests, could be incorrectly predicted to be suitable habitat. Such areas were few in the RTV Plan watersheds and omitted from consideration for contributing to red tree vole persistence. Furthermore, we did not estimate loss of acreage of suitable habitat as estimated from BEST9 from the Klondike fire because of insufficient data to appropriately implement the model. Rather, we evaluated impacts of the Klondike fire on the RTV Plan based on the value of the Rapid Assessment of Vegetation Condition after Wildlife (RAVG; https://www.fs.fed.us/postfirevegcondition/whatis.shtml [accessed March 25, 2019]). These values are based on LandSat imagery pre- and post-fire, and provides an estimate of the percentage of the basal area lost from the fire .We thus applied a rule set such that if the loss of basal area from the fire is ≤ 10% of the estimated basal area, then modeled suitable habitat would remain as such, whereas >10% loss would be assumed to result in the loss of otherwise suitable habitat.

Tree Vole Surveys

We used a diverse set of previously collected red tree vole survey data to aid in the development of the RTV Plan and to evaluate departures of model predictions with survey data collected within the watersheds. We applied the models and patterns of occurrence from the analysis of the range-wide data, described above and reported in Rosenberg et al. (2016) to the RTV Plan watersheds. Additional pre-disturbance surveys were used in Rosenberg et al. (2016) to evaluate the models. Thus, a large set of survey data contributed to the habitat model and estimates of the patterns of occurrence that were used to guide the development of the RTV Plan.

We used pre-disturbance surveys conducted within the RTV Plan watersheds during 1999-2011 to evaluate if there were substantial departures from the performance of the models at the scale of the species' entire range. We did expect some departure because the survey areas were not randomly selected and almost all of these surveys were conducted in areas that contained large numbers of hardwoods and mixed pine species encroached by Douglas-fir. These vegetation types were not typical of the areas included in the development of the habitat models. Furthermore, the surveys in the RTV Plan watersheds were almost entirely outside of the areas proposed for being managed consistent with red tree vole conservation. Of the 414 sites with nests detected during the surveys, the BEST9 model predicted 62% of those sites would provide suitable habitat, an estimate 32% lower than that observed. That is, of the 414 sites with nests detected, 32% occurred in sites predicted as unsuitable habitat. The correct classification rates for locations where tree voles were detected from these surveys was approximately 15% lower than the model performed for pre-disturbance surveys throughout the species range (Rosenberg et al. 2016). This degree of departure from overall model performance was not surprising given that the surveys were restricted to only a small subset of the type of stands from which the models were developed.

Given the large extent of surveys that contributed to model development, as reported in Rosenberg et al. (2016), with habitat very similar to that included in areas that will be managed consistent with red tree vole conservation within the RTV Plan, the habitat model we used in the RTV Plan analysis provided useful guidance in selecting areas for hybrid high priority sites and LUA-RTV. Providing guidance to

management is ultimately the goal of habitat models as used in the RTV Plan (Rosenberg et al 2016 and references cited therein).

IV. Biological Background

Location of Watersheds and Relationship with Red Tree Vole Ecology

The RTV Plan watersheds are located within the south coast subregion, within the western edge of the xeric zone and eastern edge of the mesic zone, and within the 50% density contour. The area within these watersheds were described by Jewett (1920) as the "... center of abundance..." for red tree voles, consistent with contemporary data from surveys showing very high frequency of occurrence in the south coast. In the south coast subregion, vole nests were detected in 44% of the randomly selected plots, the highest occurrence rate among all the subregions (Rosenberg et al. 2016). Although the xeric zone has low overall occurrence rates (12%; Rosenberg et al. 2016), the western edge of the xeric zone is influenced by factors that result in high occurrence in the mesic zone. Thus, this portion of the xeric zone likely has the highest rates within that zone. The RTV Plan watersheds also occur in the mesic zone, which has the highest occurrence rates (37%) of the three zones. The watersheds lie within the 50% density contour, suggesting a moderate overall relative density.

Vegetation Patterns and Environmental Conditions

Vegetation and environmental conditions were described by the Gold Beach Ranger District (2016) and summarized here. The RTV Plan watersheds occur in the Coast Range physiographic province, with the eastern edge of the watersheds almost adjacent to the northern Klamath Mountain range, the latter contributing to the diverse floral communities. Elevation ranges from <200 feet to approximately 5300 feet. Precipitation is highly variable in the watersheds ranging from 70-150 inches, with most precipitation occurring in October and May. Summers are dry and hot, more typical of the Klamath Mountains province than the Coast Range province, which, together with soil properties, contributes to the xeric conditions that give rise to the oak and pine savannahs. However, Douglas-fir forests predominate. The watersheds contain large areas of serpentine soils, another factor contributing to the floral diversity of the watersheds and the mixed pine savannahs. The watersheds are within an area prone to frequent fires, which historically maintained more open canopy and savannahs consisting of oak (Oregon white oak [*Quercus garryana*] and California black oak [*Q.* kelloggii] and mixed pine dominated stands. The mixed pine stands include sugar pine (*Pinus lambertiana*), knobcone pine (*Pinus attenuata*), western white pine (*Pinus monticola*), Jeffrey pine (*Pinus jeffreyi*), and other tree species. Historically, many of these stands likely did not provide suitable habitat for red tree voles, but with the encroachment of Douglas-fir, red tree voles frequently occupy these stands (H. Witt, USFS, pers. communication).

Large areas burned during the 2002 Biscuit Fire, particularly in the southernmost watershed (Fig. 2). Most recently, the 2018 Klondike fire affected 164,152 acres in federal ownership in multiple watersheds (USDA 2018), including 5,285 acres in all ownerships of the three primary watersheds of the RTV Plan (Table 1). All of these conditions affect the distribution and dynamics of red tree vole habitat within the watersheds.

Current and Proposed Management

Clearcut timber harvest of older Douglas-fir and replacement with plantations was the predominate disturbance prior to the Northwest Forest Plan. Current management is focused on restoration. From Gold Beach Ranger District (2016): "Management activities include: unique habitat restoration by removing encroaching trees to restore oak savannahs and woodlands, sugar pine and serpentine forest stands; accelerating development of late seral forest structures, improving landscape resilience to exotic

pathogens, and applying controlled fires across larger areas of the landscape to achieve and maintain the desired conditions." Current and proposed management is directed towards restoration of these forests by reducing conifer encroachment from open habitat types, but generally reducing stand density elsewhere in order to promote shade-intolerant species and a late-open forest structure (M. Timchak, Gold Beach Ranger District; pers. commun., April 2017). Only a portion of these management activities will reduce the acreage of suitable habitat for red tree voles from current conditions. We have included managed or candidate managed stands within the reserve land use designations that are not currently suitable red tree vole habitat, but would be expected to develop into red tree vole suitable habitat in the future. However, in some stands, restoration to ecologically-based reference conditions could render them unsuitable for red tree voles. These stands were not included in the RTV Plan, including the candidate stands to restore to open pine and oak conditions. Presumably, prior to conifer encroachment, the stands proposed for restoration treatment were not suitable habitat and were not regularly occupied by red tree voles. In stands previously managed, where Douglas-fir was planted as plantations, proposed treatments include variable density thinning to promote older forest conditions. These treatments will ultimately increase habitat suitability for red tree voles and thus were included in the RTV Plan.

Distribution of Red Tree Vole Habitat

There are four primary factors limiting red tree vole distribution in the RTV Plan watersheds: fire, serpentine soils and vegetation associated with those conditions, recent logging/establishment of plantations, and conditions favoring hardwood establishment. Although red tree voles likely occupy small patches of suitable habitat within these areas and also disperse through less suitable habitat, red tree vole distribution in the RTV Plan watersheds is limited by these primary factors. Recent fires, prior to the Klondike fire, occupy approximately 30% of the RTV Plan watersheds (38,273 acres; Table 1), although large patches of suitable habitat occur within these otherwise burned landscapes (Fig. 2). The perimeter of the 2018 Klondike fire within the RTV Plan watersheds included 5,285 acres (Table 1), but likely had minor impacts to red tree vole habitat based on the assumption that 0-10% loss of basal area did not affect habitat quality significantly (see Section VI; Fig. 2B). Serpentine soils have restricted the distribution of habitat in a large part of the watershed, covering approximately 16,702 acres (13.6% of RTV Plan watersheds; Fig. 3, Table 1). Although much of this area is currently dominated by Douglas-fir, serpentine soils have restricted the growth of Douglas-fir and many stands are generally open. Historically, most of these areas would have been dominated by open stands of mixed pine (Gold Beach Ranger District 2017). Many of these areas are proposed for restoration to mixed pine forests. Some areas, however, include patches of suitable habitat (Table 2). Although young stands, particularly those with elements of older forests, provide suitable red tree vole habitat (Huff 2016, Rosenberg et al. 2016), they often provide sub-optimal habitat which may result from a limited number of suitable foundations upon which they can build their nests (Rosenberg et al. 2016). In addition, the 3,737 acres proposed for restoration to pine and oak vegetation types (Fig. 3) may only provide sub-optimal habitat depending upon the contribution of Douglas-fir to the canopy. However, 1,467 acres of suitable habitat were predicted to occur in the candidate restoration areas (Table 2). Finally, we considered non-federally managed land as non-habitat for the purpose of developing the conservation plan, and they do not constitute any portion of the RTV Plan.

V. Conservation Plan: Approach

We used an iterative process to develop the RTV Plan, all of which included frequent consultation with staff of the Gold Beach Ranger District. The initial step was to (1) develop maps of federal land-use allocations, (2) identify non-federally managed lands, (3) delineate areas where management has occurred or is proposed to occur and would trigger red tree vole surveys if included in the plan, (4) identify areas of

serpentine soils, (5) identify recently burned areas (prior to the Klondike fire), and (6) develop maps of habitat suitability based on the habitat model BEST9.

The second step was to incorporate aerial imagery and maps of vegetation type and stand age to augment the pixelated habitat maps that are a result of the modelling process using GNN. We used aerial imagery to broadly identify stands that were similar in structure to adjacent areas of suitable habitat. These areas were then designated as the initial selection of suitable habitat for the conservation plan. GIS-based estimates of vegetation type and stand age (M. Timchak, Gold Beach Ranger District, pers. communication, April 25, 2017) were used to corroborate areas dominated by Douglas-fir and approximately >80 years of age. At this point, we excluded fuel management zones (FMZs) from inclusion in the RTV Plan until connectivity needs were assessed. Fuel management zones are typically 400 feet wide and were broadly distributed in the RTV Plan watersheds (Fig. 4).

The third step in developing the plan was to evaluate connectivity within the RTV Plan watersheds and to each adjacent watershed outside of the RTV Plan watersheds. We first used areas of modeled suitable habitat to guide selection of general areas of connectivity, which we augmented with both aerial imagery and GIS-based estimates of age of Douglas-fir stands. We identified areas with the lowest apparent connectivity. In addition, we identified fuel management zones (FMZs) to include in the plan so that they did not create potential barriers to connectivity as per rule 1(a) for connectivity, which limits gaps in the forest canopy to less than 100 feet (see section "How this Plan Meets the High Priority Site Management Recommendations Rule Set"). We then proposed areas as potential connectivity for inclusion in the RTV Plan to the staff of the Gold Beach Ranger District.

The analyst conducted a visit to selected sites within the RTV Plan watersheds with Dr. Forsman, who provided guidance as to the habitat suitability of areas visited, and with the staff of the Gold Beach Ranger District. Following ground inspections, Dr. Forsman and the analyst met with staff to go over in detail each proposed area included in the draft RTV Plan in light of results of the field trip. This was a crucial aspect of the conservation planning process as on-the-ground knowledge of site conditions is needed for an effective plan. Ultimately, managed areas that would likely provide suitable habitat in the future were included in the RTV Plan. Most areas dominated by serpentine soils were excluded from the RTV Plan due to sub-optimal habitat connectivity. Serpentine soil areas included in the RTV Plan were those that were needed to enhance connectivity within the RTV Plan and to adjacent watersheds. The field visit and the resulting modified RTV Plan demonstrated the large extent of red tree vole habitat in the plan and that would result in a well distributed population and extensive connectivity throughout most of the RTV Plan watersheds.

The southern portion of the RTV Plan watersheds, specifically the Lawson Creek watershed, was the only area that included matrix and riparian reserve land-use allocations, and a few areas of reserve land use allocation (LSR, etc.). To increase the amount of habitat managed for red tree vole conservation into this section of the watersheds and to enhance connectivity to adjacent watersheds, we identified large HPS and riparian reserves that are to be managed consistent with red tree vole conservation. We combined matrix and riparian reserves to form "hybrid" high priority sites that resulted in much larger areas than the 10 acre minimum and 25 acre recommendation as per the rule set for size of high priority sites (rules 2(a-d); see section "How this Plan Meets the High Priority Site Management Recommendations Rule Set"). These proposed additions were evaluated for conflicts with other management objectives. We then quantified acreage and habitat suitability to describe the RTV Plan and provide a basis for the final recommendations.

Finally, we considered areas outside of the RTV Plan watersheds that would enhance connectivity within the RTV Plan. This was only needed in the narrow area at the intersection of Lawson Creek and Shasta

Costa Creek watersheds, where a mix of private lands, proposed restoration areas, and non-federal lands otherwise limited apparent connectivity (Fig 4).

VI. Conservation Plan: Strategy

Overview

The RTV Plan is composed mostly of land-use allocations consistent with red tree vole conservation, all of which are comprised of reserve allocations, consistent with the high proportion (90%) of the RTV Plan watersheds that are in reserve land-use allocations (Fig. 5; Table 1). The southern portion of the RTV Plan watersheds has a lower proportion of reserve land-use allocations and we therefore included matrix and riparian reserve land-use allocations in the RTV Plan for this area. The RTV Plan includes 83,959 acres in the three RTV Plan watersheds and the addition in the Indigo Creek watershed. Within only the three RTV Plan watersheds there are 83,391 acres (Table 1), comprising 71% of the federal lands. Within the entire RTV Plan (including the portion in Indigo watershed) there are a total of 40,437 acres of habitat predicted to be suitable for red tree voles (Table 2). This comprises 48% of the area of the RTV Plan for which habitat was evaluated by the model. The RTV Plan includes 568 acres within the Indigo watershed to provide for connectivity, and of this, 228 acres (40% of the area modeled in the Indigo watershed addition) is predicted to be suitable habitat Table 2). The RTV Plan contains the majority (84%) of the suitable habitat within the RTV Plan watersheds exclusive of non-federal land.

Most of the modeled suitable habitat within the RTV Plan was likely not affected by the Klondike fire based on RAVG estimates of the loss of basal area (Fig. 2B), and therefore no changes to the Plan were made. There was a total of only 248 acres of either suitable or unsuitable habitat that had estimates of >10% loss of basal area from the Klondike fire within the entire RTV Plan. Most (597 acres) of the area in federal ownership in the RTV Plan watersheds with loss of basal area >10% occurred in the non-high priority sites. To allow for the potential loss of suitable habitat, we assumed these acres were non-suitable to red tree voles. This is very conservative because many areas with >10% loss of basal area likely serve as suitable habitat. The Klondike fire impacted a large area, but the Klondike fire within the RTV Plan likely had negligible impact on suitable habitat for red tree voles. We estimated the greatest potential loss to be 248 acres, based on the assumption of no change to habitat suitability for ≤ 10% loss in basal area and that all of the 248 acres with >10% basal area loss were suitable habitat prior to the fire.

Land-Use Allocations Managed Consistent with RTV Conservation (LUA-RTV)

Land-use allocations in the RTV Plan that are managed consistent with red tree vole conservation (LUA-RTV) are almost entirely within reserve allocations, which consists of administratively withdrawn, congressionally reserved, and late-successional reserves, including occupied marbled murrelet (*Brachyramphus marmoratus*) sites, within the three RTV Plan watersheds. We excluded a select set of managed and proposed managed areas, as well as special use/wildlife areas that may be managed inconsistent with red tree vole conservation. In the southern portion of the RTV Plan watersheds, a number of riparian reserves are included in the RTV Plan. Because we adjoined these to high priority sites in the matrix land use allocation, we discuss these in the section below, "Hybrid High Priority Sites".

There is a considerable amount of suitable habitat within the LUA-RTV dispersed throughout most of the RTV Plan watersheds, with the exception of the southern portion. Most of the LUA-RTV, including the areas that are predicted as non-suitable habitat are composed of Douglas-fir stands ≥30 years old (M. Timchak, Gold Beach Ranger District; pers. commun., April 2017). The areas within the LUA-RTV that are dominated by stands <30 years old area are a result of recent fires, but they are managed consistent

with red tree vole conservation. These areas should contribute to red tree vole persistence in the RTV Plan watersheds as the stands mature. Some stands included in the LUA-RTV consist of serpentine soils that contained suitable habitat and that imagery suggested would provide for connectivity. Other stands in serpentine soils and included in the LUA-RTV were largely composed of unsuitable habitat and would likely only provide limited connectivity. All of these areas met the criteria that they would be managed consistent with red tree vole conservation; albeit the serpentine soil areas likely have limits to the degree of suitability due to the limited inherent capability of serpentine soils to grow Douglas-fir trees.

The main limitation to connectivity within the three RTV Plan watersheds and within the LUA-RTV specifically, occurs at the narrow intersection of Lawson Creek and Shasta Costa Creek watersheds. The limitation in this area is largely due to the extent of non-federal lands and candidate restoration stands that would be predicted as non-suitable habitat as the restored conditions are created, as well as areas of serpentine soil (Fig 3.). To increase connectivity, we added a large block (568 acres) outside of but adjacent to the project watersheds in the Indigo Creek fifth-field watershed (Fig. 3). Of the 568 acres, 40% was composed of predicted suitable habitat but there were also stands <30 years of age, but that would be expected to develop into suitable habitat in the future. Based on the location of the perimeter of the Klondike fire, 197 acres (34.7%) of the Indigo Creek addition was impacted by the fire (Fig. 2B). However, almost all of the area within the fire perimeter (193 acres) had an estimated basal area loss of ≤ 10%. Based on these estimates, the Indigo Creek addition should retain its intended purpose of habitat connectivity.

The FMZs (400 foot width) intersect many areas within the LUA-RTV portion of the RTV Plan (Fig. 4) and limit connectivity according to the rule set (section "How this Plan Meets the High Priority Site Management Recommendations Rule Set"). To enhance connectivity, we selected a series of segments of the FMZs to include in the RTV Plan, and thus will be managed consistent with red tree vole conservation. The acreage of the FMZs managed consistent with red tree vole conservation that occurs in the reserve land use allocation is 655 acres (Table 1). A total of 64 acres (9.8%) are within the Klondike fire perimeter, with 49 acres estimated to have >10% loss of basal area. We expect the relatively small loss of acreage within the FMZ to have negligible, if any, negative effects on connectivity, the sole purpose of the FMZ in the Plan.

Hybrid High Priority Sites (Hybrid-HPS)

To allow for greater distribution of red tree voles in the southern portion of the RTV Plan watersheds than the LUA-RTV would allow and to increase connectivity to adjacent watersheds in that portion of the RTV Plan, we identified matrix and riparian reserve land-use allocations that were most appropriate for meeting red tree vole conservation goals and limiting restrictions on managed or candidate managed stands. We created hybrid high priority sites, which were mostly large areas that were composed of matrix and riparian reserves. These areas effectively increased the size of selected riparian reserves to provide connectivity from the large blocks of LUA-RTV to adjacent watersheds. These areas range from 40-1,106 acres and as such were much larger than the >25 acre recommendation and much greater than the minimum 10 acres for high priority sites as per the rule set for high priority sites (2[a-d], see section "How this Plan Meets the High Priority Site Management Recommendations Rule Set"). These areas comprise 1,582 acres, consisting of 846 and 736 acres in matrix and riparian reserve land-use allocations, respectively. Because of extensive fires in this portion of the RTV Plan watersheds (Fig. 2), most of the hybrid high priority sites are predicted to comprise unsuitable habitat (86%) for red tree voles (Table 2) but would be expected to develop into red tree vole habitat as the stands mature.

Because of the very large size of the hybrid high priority sites, the lack of suitable habitat in most areas at this time, and that a majority of the area of the RTV Plan watersheds is in LUA-RTV, we concluded the rule set requiring links to three other high priority sites or LUA-RTV was functionally met (see section

"How this Plan Meets the High Priority Site Management Recommendations Rule Set). Within the hybrid high priority sites, there were few FMZs (Fig. 4) and in only one area did they potentially limit connectivity. To ensure the rule set requiring gaps of less than 100 feet (see section "How this Plan Meets the High Priority Site Management Recommendations Rule Set") was met, we selected one segment of the FMZs within matrix land use allocation to include in the RTV Plan and thus be managed for red tree vole conservation (Fig. 4).

Connectivity to Adjacent Watersheds

In addition to enhancing connectivity within the RTV Plan watersheds, we also included additional areas in the RTV Plan to provide reasonable assurance of linkages to adjacent watersheds. We identified potential linkage areas in a two-step process. First, we identified reserve areas outside of the RTV Plan watersheds that included suitable habitat in each of the watersheds. The large expanse of reserve areas (Fig. 1) facilitated providing ideal and extensive linkages throughout most of the RTV Plan watersheds. However, we identified few linkages in the southern portion of the RTV Plan watersheds, entirely within the Lawson Creek watershed. Most of this area is currently predicted as unsuitable habitat to red tree voles, largely because of recent fires. This motivated the second step in identifying linkages. To increase connectivity between this watershed and the adjacent watersheds, we included a hybrid of riparian reserves and high priority sites within matrix land-use allocations, as described in the previous section, "Hybrid High Priority Sites". Because there were few concentrated areas of predicted suitable habitat in the southern portion of the RTV Plan watersheds, we chose areas that had some suitable habitat, preferentially selecting riparian reserves that are managed consistent with red tree vole conservation, and enlarging such areas by including adjacent areas that are expected to develop into suitable habitat when managed in a manner consistent with red tree vole conservation. We worked collaboratively with staff from the Gold Beach Ranger District to identify areas that met these conditions and goals, while minimizing inclusion of areas that are actively managed for timber production.

The hybrid high priority sites that we created were much larger than the guidelines in the HPS MR. Although smaller areas would have allowed a greater number of high priority sites and thus facilitated meeting the rule set specifying that each high priority site be connected to three other high priority sites or LUA-RTV (Huff 2016:16), these large areas provided greater conservation value to red tree voles. Each of these hybrid high priority sites connected the adjacent watersheds to the large network of LUA-RTV (Fig. 5). None of the hybrid high priority sites were within the Klondike fire perimeter (Fig. 2B).

The areas outside of the RTV Plan watersheds, with the exception for Indigo Creek watershed, are not considered a part of this RTV Plan. However, the area identified as LUA-RTV habitat in the Indigo Creek watershed is part of this conservation plan and is required to be managed for red tree vole conservation (Fig. 5). This area was needed in order to meet the connectivity rule set between watersheds within the RTV plan watersheds.

How this Plan Meets the High Priority Site Management Recommendations Rule Set

The plan described here (Fig. 5) exceeds the HPS MR due to the large extent of well-distributed habitat will be managed consistent with red tree vole conservation. Most of the RTV Plan watersheds are in reserve land-use-allocation, and the hybrid high priority sites outside of those allocations were identified to meet the HPS MR rule set. The resulting plan has very large, well-connected areas of suitable habitat and areas that will develop into suitable habitat as the forest matures. The RTV Plan provides for resiliency to areas with high fire risk or other hazards that may reduce habitat quality in the future. The very large blocks of habitat and the fact that a majority of the watershed will be managed consistent with

red tree vole conservation provides resiliency. As per the rule set, each adjacent watershed has continuous links to its ridgeline from either LUA-RTV or the hybrid high priority sites (Fig. 5). Because of the extensive area delineated for red tree vole conservation, this plan exceeds the expectations described in the HPS MR.

In the sections that follow, we address how the RTV Plan met each rule, in numerical order, as described by Huff (2016:17-23).

A. Land-use allocations managed consistent with red tree vole conservation (LUA-RTV)

Land use allocations managed consistent with red tree vole conservation (LUA-RTV) were identified and mapped. See section IV "Conservation Plan: Strategy, Land-Use Allocations Managed Consistent with Red Tree Vole Conservation" on page 9 for details demonstrating that the RTV HPS MR procedures were followed. A majority (68%) of the federal lands in the three watersheds are contributing to the foundation of red tree vole conservation (Table 1). Activities in these areas would not trigger the need for red tree vole pre-disturbance surveys.

B. High priority sites (HPS)

1. Composition

(a) All of the sites are dominated by Douglas-fir and (b) include patches of older forest with large trees but because of recent fires most of the acreage is of younger forest and currently predicted as non-suitable red tree vole habitat. (c) Because of the extent of recent fires where high priority sites were needed to accommodate the lack of LUA-RTV, old-growth forest is absent or rare and therefore, was not available, and (d) the older forest is fragmented so contiguous forest was also not available. (e) We selected areas with high canopy closure but we also had to select recently burned areas because of limited habitat in the area of the watershed where high priority sites were needed. These areas are expected to develop into forests with high canopy closure as they mature. (f) The hybrid approach we used to combine matrix and riparian reserve land-use allocations allowed for larger sites (40-1,106 acres), allowing for more flexibility in the composition of the site. (g) The large size of the hybrid high priority sites is a key feature of the RTV Plan, but the sites all currently contain some young forest due to old forests being eliminated by fire or the inherent capability of the land type. (h) Specific areas within the sites were included based on predicted suitability of the habitat for tree voles which resulted in selecting either older forest (applies to rule b and c) or young forests with large trees nearby. (i) We avoided including small patches of forest, preferring to create larger areas of hybrid high priority sites that include both young and old forest that can provide refugia. (j) The large and well distributed hybrid high priority sites will contribute to meeting resiliency.

2. Size of high priority sites

(a, b, c, d) All sites are ≥40 acres, (e) despite the very extensive area of large LUA-RTV. Therefore, the RTV Plan exceeds the rule requiring sites are >10 acres and exceeds the recommendation for sites to be >25 acres. Furthermore, all sites are connected to large areas of LUA-RTV regardless of the size of the high priority sites.

3. Location of high priority sites

(a) Most of the RTV Plan watersheds are in LUA-RTV in the RTV Plan. The only areas where high priority sites were needed to meet the rule set was in the southern portion of Lawson Creek watershed.

We located six high priority sites to enhance the distribution of habitat in the RTV Plan. (b) Importantly, each of the high priority sites was designed to provide linkages to adjacent watersheds, (c) where LUA-RTV would otherwise be limiting. (d) All of the high priority sites are in fire prone areas as evidenced by the large extent of recently burned areas. Redundancy was achieved by multiple high priority sites, all very large and well connected to LUA-RTV. (e) No other rare species were evaluated regarding site selection. However, there were no areas designated for conservation of specific species other than marbled murrelets but sites designated for this species are treated in the Northwest Forest Plan as late seral reserves and are thus included in the RTV Plan as LUA-RTV. (f) connectivity to adjacent watersheds was the primary determinant of locating these sites and were based on location of landscape features and ecological conditions that may limit red tree vole movement.

4. Number of high priority sites

(a) We included six hybrid high priority sites, all of large size, and connected to the extensive area of LUA-RTV. (b and c) Rather than increasing the number of high priority sites to meet the rule of connecting each one to three other HPS or LUA-RTV, we increased their size and ensured linkage to the large blocks of LUA-RTV. This provides for larger tree vole populations at each site and thus enhances connectivity between these larger populations and the adjacent watersheds. (d) There was relatively low acreage of LUA-RTV in the Lawson Creek watershed and thus the hybrid high priority sites enhanced the distribution of red tree vole habitat (current and future) and linkages to adjacent watersheds. This provided the motivation to include hybrid high priority sites in the RTV Plan.

C. Connectivity

Connectivity in the RTV Plan is largely achieved by the extensive and nearly continuous LUA-RTV in all but at the intersection of Lawson Creek and Shasta Costa Creek watersheds and in the southern portion of Lawson Creek watershed. Areas were added to this area to enhance connectivity as described below.

1. Composition of corridors or patches managed as connectivity areas

(a) Where gaps of forested areas ≥100 feet exist, or potentially could occur given possible management alternatives such as FMZs, canopy coverage was provided by including extensive LUA-RTV, hybrid high priority sites, and selected FMZs as hybrid high priority sites and as LUA-RTV and managing the areas consistent with red tree vole conservation. We included 657 acres of FMZs within hybrid high priority sites and LUA-RTV to provide continuous coverage. Hybrid high priority areas were selected in part based on areas with continuous canopy cover. However, in many recently burned areas, there was no alternative but to allow breaks in the canopy of ≥100 feet. We expect most areas to mature into continuous canopy cover. (b and c) Because of fire, young forests were often the only choice for areas to be managed for red tree vole conservation in some parts of the southern portion of Lawson Creek watershed, and this included areas intended to enhance connectivity.

2. Width of corridors and size of landscape patches

(a and b) All areas in the RTV Plan intended to function as connectivity are >300 feet wide and >5 acres as demonstrated in the hybrid high priority sites and within the LUA-RTV by the inclusion of segments of the FMZs. (c and d) Riparian reserves were widened to facilitate red tree vole dispersal. This is reflected in the RTV Plan by the addition of matrix areas adjacent to riparian reserves, creating large hybrid high priority sites. There is a broad array of stand age-classes of Douglas-fir in the hybrid high priority sites in large part because of fire.

3. Location of connectivity areas on the landscape

(a) Connectivity in the RTV Plan has been enhanced through additions of hybrid high priority sites and 568 acres in the adjacent Indigo Creek watershed. This resulted in connectivity throughout the RTV Plan watersheds and to adjacent watersheds. (b) All of the LUA-RTV and hybrid high priority sites are within the red tree vole survey zone; therefore, all connectivity occurs within the survey zone of the red tree vole. (c) Resiliency has been achieved through the large proportion of the landscape in the LUA-RTV and the addition of multiple connections to adjacent watersheds, and by the inclusion of the large hybrid high priority sites. (d) We utilized multiple sources to identify gaps in connectivity, including non-federally managed lands, which we assumed were barriers to movement such that the focus of the RTV Plan was on National Forest system lands. We also utilized FMZs, candidate restoration areas, recent burns, areas of serpentine soils, and ultimately, aerial imagery as sources. (e) Checkerboard ownership does not exist in these watersheds. (f) Almost all of the linkages to adjacent watersheds are to reserve land-use allocations, with the exception of the hybrid high priority sites in the southwestern portion of Lawson Creek watershed where almost the entire adjoining watershed was in matrix land-use allocation. Some areas are not currently suitable habitat, and may not now provide connectivity. However, they are expected to develop into habitat suitable for connectivity as well as other life functions as the forest matures. (g) We achieved connectivity to adjacent watersheds in the southern portion of the RTV Plan watersheds largely through extending riparian reserves, connected to large LUA-RTV blocks, via adding matrix land-use allocations to form the hybrid high priority sites.

VII. Non-High Priority Sites (Non-HPS)

All areas of federal management within the RTV Plan watersheds that are not either LUA-RTV, hybrid high priority sites, or the selected fuel management zone linkage areas within these designations, should be considered as non-high priority sites (Tables 1 and 2, Fig. 5). In total, the non-high priority sites, including the FMZs not being managed consistent with red tree vole conservation, comprise 35,171 acres, 29% of the area within the RTV Plan watersheds (Table 1). There are approximately 7,943 acres predicted as suitable habitat in the non-high priority sites, 23% of the total acreage of non-high priority sites for which habitat was evaluated by the model (Table 2). There are no previously designated red tree vole sites in the non-high priority sites where the 10 acre buffer mitigation protocol was applied so there is no need to release sites from such management. Furthermore, any newly discovered red tree vole sites within the non-high priority site area will not require site management. The non-high priority sites do not require pre-disturbance surveys (Huff 2016).

VIII. Management within the RTV Plan Areas

All of the areas included in LUA-HPS or hybrid high priority site will be managed consistent with red tree vole persistence. Such management is expected to continue for the duration of the RTV Plan, as described below. Importantly, the only areas outside of the three RTV Plan watersheds that are included in the RTV Plan are the 568 acres in the Indigo Creek watershed (Table 1). Other areas shown outside of the RTV Plan watersheds demonstrate how the RTV Plan connects to adjacent watersheds, but these areas are not covered by the RTV Plan.

The following excerpt is from page 25 of Huff (2016) and describes management that is allowed within land-use allocations managed consistent with red tree vole conservation:

> "Management within these land-use allocations will continue to follow the standards and guidelines within the specific land management plan for the National Forest or BLM District. No activities that would trigger surveys as identified in the survey protocol (Huff, et al. 2012) should occur within these land-use allocations. Young stand management is acceptable; however, the age

or structure of the stands proposed for treatment should not trigger the need for pre-disturbance surveys."

If management which could trigger pre-disturbance surveys is planned within LUA-RTV (land use allocation managed consistent with red tree vole conservation) or hybrid-HPS (hybrid high priority sites) in areas that would trigger pre-disturbance surveys, then a revision to the RTV Plan would be required (Huff 2016). Young stand management is acceptable as described in the excerpt in the previous paragraph.

IX. Duration of Strategy

The red tree vole plan enacted for the Lawson Creek, Shasta Costa Creek, and Stair Creek fifth-field watersheds, and the 568 acres within Indigo Creek fifth-field watershed, provides the management direction for red tree voles in the RTV Plan watersheds until updated, replaced or removed through a new project NEPA decision (Huff 2016:24). The expected longevity of the RTV Plan is 15 years or sooner if new information would necessitate an update. If events occur in which vegetative conditions on the ground would be changed to those areas identified as contributing to red tree vole conservation and they no longer are functioning to provide for red tree vole, then a review and update of this RTV Plan would be needed. An example of an event that would trigger a review of and may require an update to this RTV Plan would be an extensive wildfire occurring in one or more of the three watersheds.

VII. Information to Trigger a Change in Management

We do not foresee any reasonable evidence that would modify a significant change in management under this plan for the duration of the strategy as described above, primarily because of the large extent of habitat within this plan and limited options for significant additions. Although habitat models other than what we used would alter the estimates of the distribution and abundance of suitable habitat, the general corroboration with GIS-based data on vegetation and stand age, as well as photo imagery, provide strong support that the foundation of the plan would remain unchanged if different models, or GIS projections, were used. The data source for the vegetation type and stand age was not considered by Gold Beach Ranger District to be very accurate, and we used their local knowledge to confirm the decisions made in this document. However, if future data determines that these are sufficiently inaccurate that the RTV Plan misinforms delineations of habitat suitability now and in the future, then a revision to the RTV Plan may be appropriate. Climate change and plant disease may alter the distribution of red tree vole habitat, but any predictions on such changes would be naïve to make at this time, and if such changes occurred, they would likely be within most of the RTV Plan watersheds. Fire has had a major effect on the extent of red tree vole habitat within the RTV Plan watersheds (Fig. 2) and it is reasonable to expect further fires in the future, such as the 2018 Klondike fire demonstrates. The large extent of currently suitable habitat and the other areas that are expected to mature into suitable habitat will provide resilience to future fires. With further extensive fires, if the RTV Plan is insufficient for providing a reasonable level of assurance of persistence, identification of areas outside of the RTV Plan watersheds would likely be needed.

VIII. Literature Cited

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Attachments: Tables, Figures and Maps

Table 1. Acreage of land-use allocations, management units, and ecological conditions within the RTV Plan watersheds including Lawson Creek, Shasta Costa Creek, and Stair Creek watersheds , and a portion of Indigo Creek watershed. Acreage estimates may vary slightly based on GIS map projections, however, the conclusions of the Plan are robust to minor variations.

Spatial Unit	Acres	% of WS
Fifth Field Watersheds	122,570	100
Federal management	118,005	96.3
Reserve land use allocation	110,197	89.9
Matrix land use allocation	6,550	5.3
Riparian land use allocation	1,258	1.0
Red tree vole conservation strategy within the entire RTV Plan watersheds' including the Indigo watershed addition	83,959	NA
Red tree vole conservation strategy within RTV Plan watersheds[1]	83,391	68.0
Land-use allocations managed consistent with tree vole conservation (LUA-RTV) within RTV Plan watersheds[1,2]	81,809	67.0
Land-use allocations managed consistent for tree voles (LUA-RTV) in Indigo watershed	568	NA
Hybrid high priority sites—matrix allocation[2]	846	0.5
Hybrid high priority sites—riparian reserve allocation	736	0.6
FMZs within LUA-RTV	655	0.5
FMZs within hybrid high priority sites (matrix)	2	<0.1
Non-high priority sites	35,171	28.7
Non-high priority sites within reserve allocation	33,711	27.2
Non-high priority sites within matrix allocation	825	0.7
Non-high priority sites within riparian reserve allocation	635	0.5
Serpentine soils	16,702	13.6
Burn areas (year 2000 or later)	38,273	31.2
Klondike Fire (2018)[1]	5,285	4.5
Candidate restoration stands	3,737	3.0

[1] Does not include acreage within Indigo watershed.
[2] includes FMZs (fuel management zones)

Table 2. Acreage estimates of suitable habitat as predicted by habitat model BEST9. Areas with missing data for the habitat model are not included in the acreage assessment. Acreage estimates may vary slightly based on GIS map projections, however, the conclusions of the Plan are robust to minor variations.

	BEST9	
Red Tree Vole Conservation Plan Element	**Non-Suitable (%)**	**Suitable (%)**
Red tree vole plan watersheds (federal management only)	69,596 (59.4)	47,560 (40.6)
Red tree vole conservation strategy[1]	43,660 (51.9)	40,437 (48.1)
Indigo watershed addition	227 (40.0)	341 (60.0)
Land use allocation managed consistent with tree vole conservation (LUA-RTV)[1, 2]	41,974 (51.2)	39,994 (48.8)
Hybrid high priority sites[2]	1,345 (86.2)	215 (13.8)
Candidate restoration stands	2,212 (60.1)	1,467(39.9)
Serpentine soils	13,913 (84.3)	2,596 (15.7)
Non-high priority sites	26,816 (77.1)	7,943 (22.9)

[1]Includes the RTV Plan acreage in Indigo watershed

[2] includes FMZs (fuel management zones)

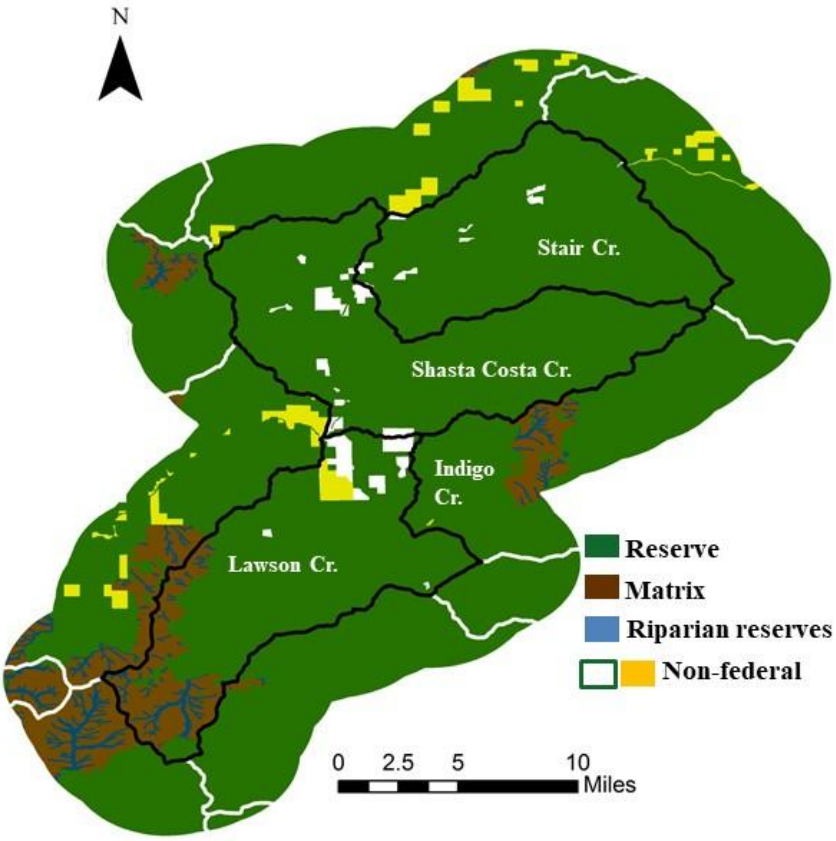

Figure 1. Land-use allocations in the three RTV Plan watersheds, Indigo Creek watershed, and adjacent fifth-field watersheds. A small portion of Indigo Creek watershed was included in the RTV Plan. Riparian reserves also occur in the late-successional reserve, congressionally reserved areas, and administratively withdrawn areas, but are not mapped here because the standards and guidelines for these land-use allocations are more restrictive than the riparian reserve guidelines. Reserve areas shown here include late-successional reserve, congressionally reserved areas, administratively withdrawn areas, and occupied marbled murrelet sites.

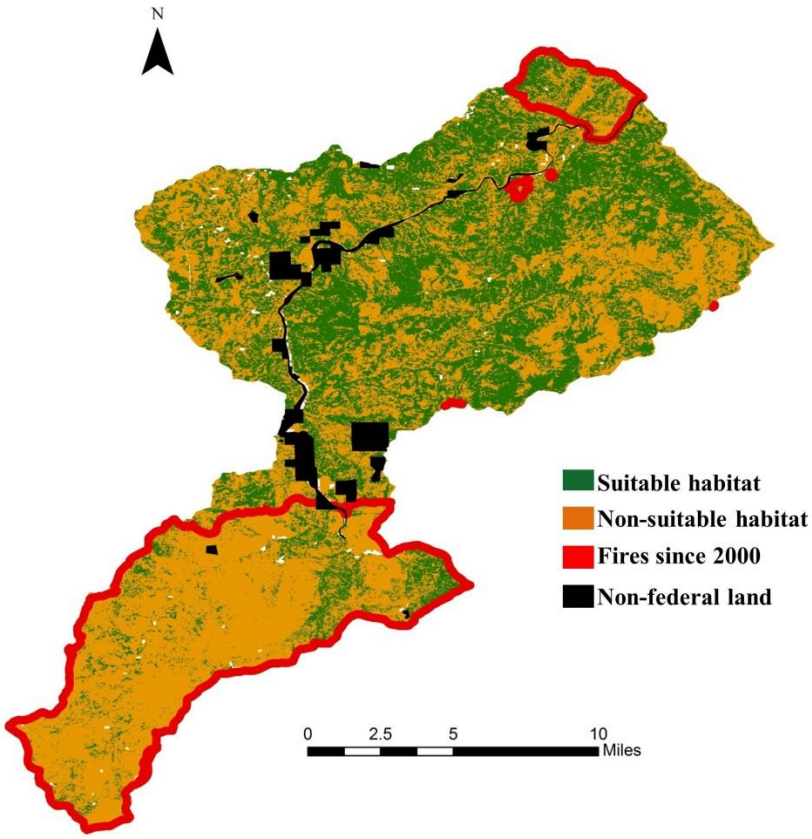

Figure 2. Suitable and non-suitable habitat, as predicted by model BEST9, within recently burned areas (since 2000, but excluding the Klondike fire) in the RTV Plan watersheds. Small patches of suitable habitat exist within some areas of recent fires.

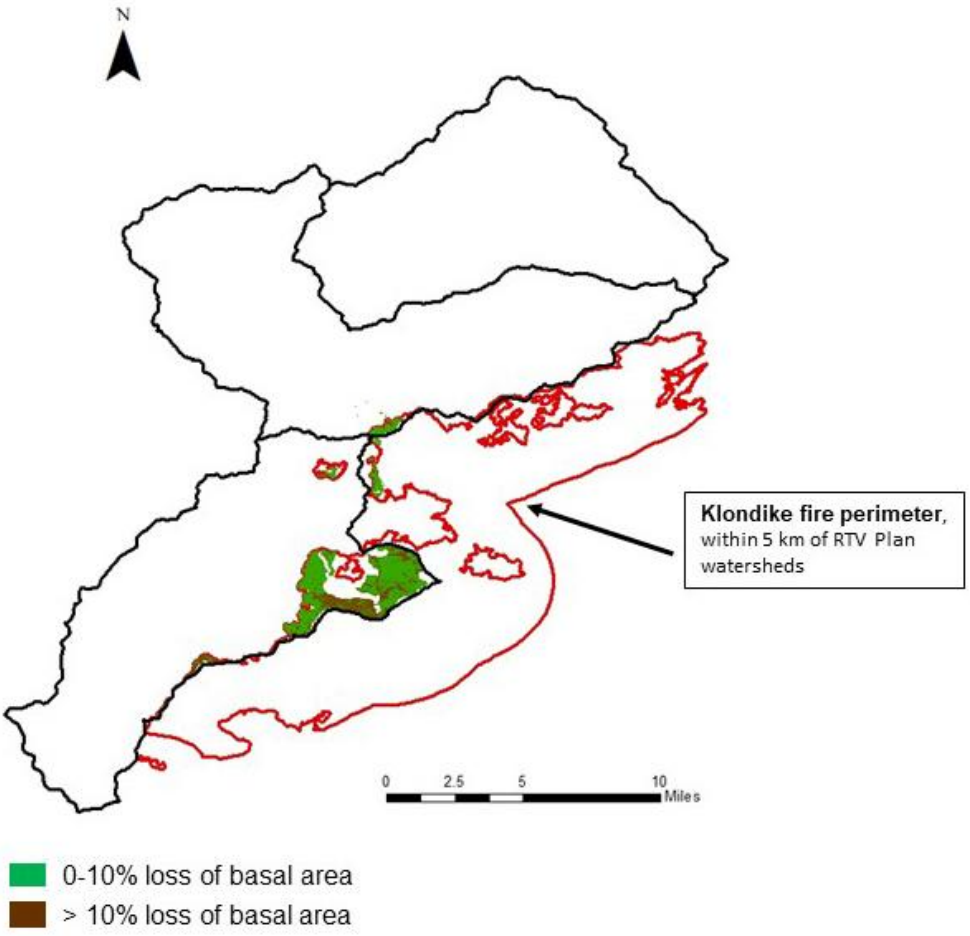

Figure 2B. Extent and intensity of the Klondike fire within 5 km of the RTV Plan watersheds. The fire perimeter is shown for the area within 5 km of the RTV Plan watersheds. Within the RTV Plan watersheds and the Indigo addition, most of the fire had minimal loss of basal area (≤ 10%) within the RTV Plan, including LUA-RTV, Hybrid HPS, and the FMZ Gates. All three of the contributing elements of the RTV Plan are shown here. Loss of basal area was estimated from the Rapid Assessment of Vegetation Condition after Wildlife.

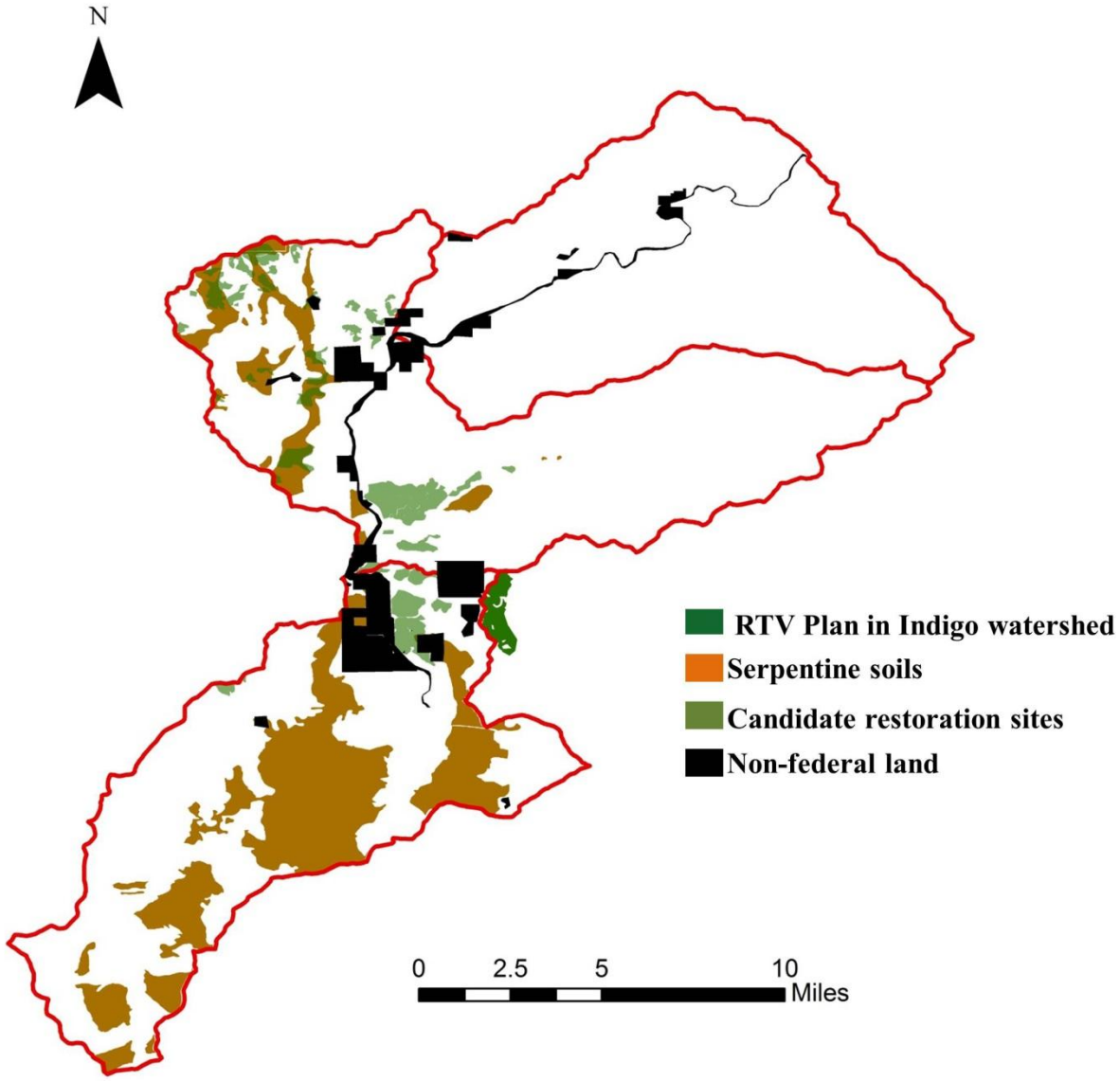

Figure 3. Extent and location of non-federal lands, serpentine soils, and candidate restoration stands within RTV Plan watersheds illustrating the restriction of connectivity near the intersection of the Lawson Creek and Shasta Costa Creek watersheds. The addition of 568 acres of reserve land to the RTV Plan

from within the Indigo watershed enhanced connectivity in this most narrow section of all three RTV Plan watersheds.

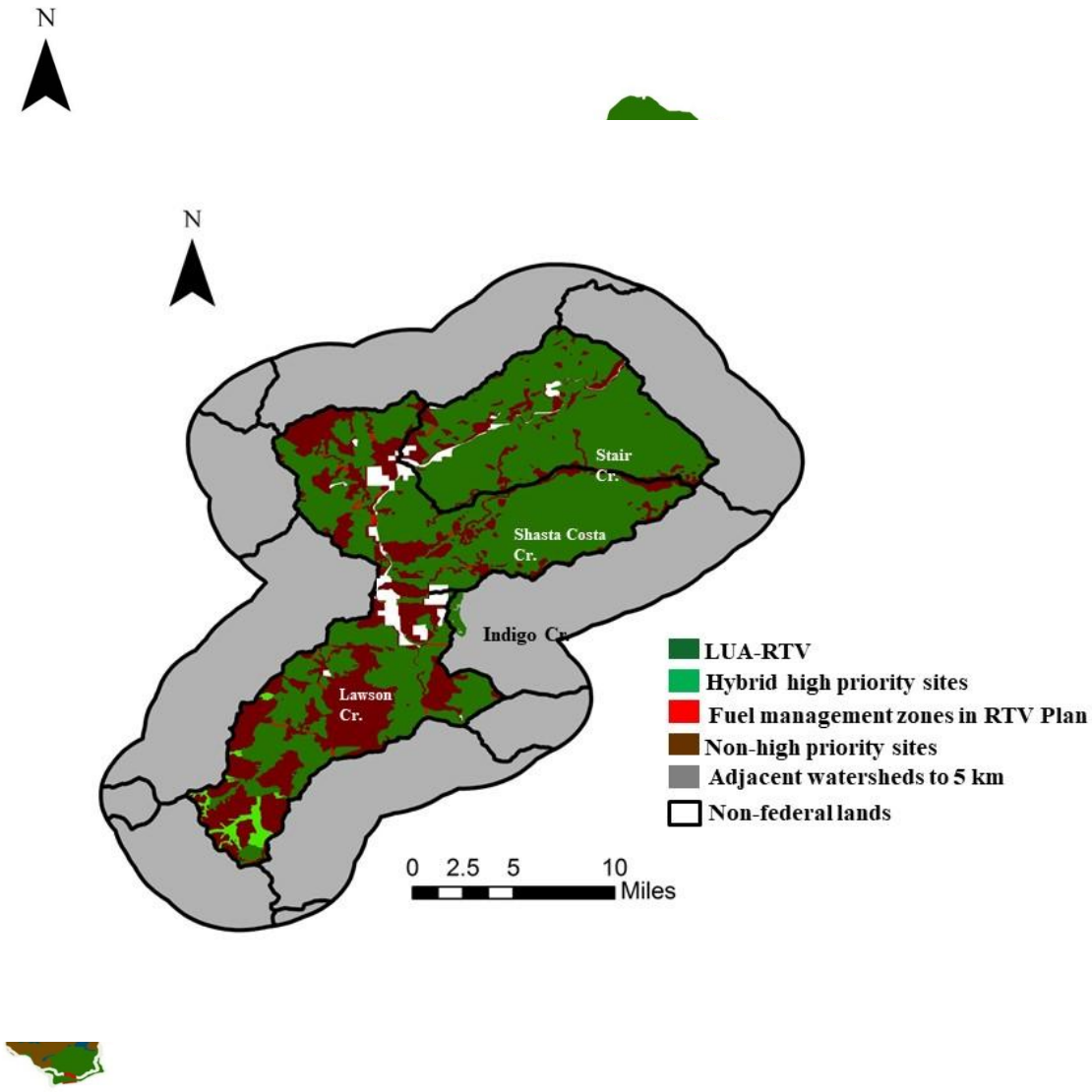

Figure 4. Fuel Management Zones (FMZ) within matrix and reserve land-use allocations. Segments of the FMZs were included in the RTV Plan to enhance connectivity and meet the red tree vole HPS MR rule set requiring gaps in the forest canopy of <100 feet.

Figure 5. Red tree vole conservation plan (RTV Plan) within the RTV Plan watersheds. The RTV Plan also includes 568 acres in the Indigo Creek watershed. Land-use allocations consistent with red tree vole management (LUA-RTV) comprise the largest portion of the plan, with hybrid high priority sites only in the southern portion. Segments of fuel management zones were included in the plan to enhance

connectivity. Areas not identified as LUA-RTV or hybrid high priority sites are considered non-high priority sites. Multiple linkages extend from the RTV Plan into each adjacent watershed.